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ABSTRACT

In the fall of 1984, the Education Commission of the States (ECS) was awarded a grant from the U.S. Secretary of Education's Discretionary Fund to identify alternative state roles for improving instructional materials in mathematics. To help state leaders define an appropriate and effective role in upgrading these materials, ECS proposed first to identify the complex problems surrounding the development and adoption of materials and then to suggest new ways for state leaders to work with other state leaders, districts and publishers to improve instructional materials. To identify what was wrong with textbooks, more than 70 teachers, professors, publishers and state and local education agency staff were asked to participate in a survey. This document is a synthesis of the survey responses. The survey instrument appears in Appendix A; survey participants are listed in Appendix B. (CW)

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WHAT'S WRONG WITH MATHEMATICS TEXTBOOKS?

VIEWS FROM THE FIELD

SI-86-3

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We wish to thank the many teachers, professors, publishers, researchers and state and local education agency staff who responded to our survey on issues related to high-quality instructional materials. The list of names, too long to include here, can be found in Appendix B of this report. We appreciated their honesty, candidness and strong personal and professional interest in the issue.

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I. INTRODUCTION

In the fall of 1984, the Education Commission of the States (ECS) was awarded a grant from the U.S. Secretary of Education's Discretionary Fund to identify alternative state roles for improving instructional materials in mathematics. To help state leaders define an appropriate and effective role in upgrading these materials, ECS proposed first to identify the complex problems surrounding the development and adoption of materials and then to suggest new ways for state leaders to work with other state leaders, with districts and with publishers to improve instructional materials.

To identify what is wrong with textbooks, we asked more than 70 teachers, professors, publishers and state and local education agency staff to participate in a survey. All these participants had a strong interest in textbooks, so they were able to suggest solutions as well as to delineate problems.

A synthesis of the survey responses follows. The survey instrument appears in Appendix A; survey participants are listed in Appendix B.

II. THE SELECTION PROCESS

Resources

More than half of the respondents cited inadequate funding of instructional materials and the selection process as deterrents to the use of high quality mathematics materials. Money to purchase materials locally is limited, forcing some districts to adopt a single textbook that may not be appropriate for differing ability levels. Several respondents suggested that "materials are selected on the basis of cost alone." Another wrote that the opinion of the reviewer may not even be seriously considered. Survey participants indicated that books and other materials are often worn out by the fifth year of a six-year adoption cycle. One noted that limited budgets force districts to continue using the same materials for twelve years or more.

State funds are not always earmarked for instructional materials, and in some cases earmarked money may be used for materials other than textbooks. One survey participant argued that low funding makes it impossible for publishers to produce a variety of materials. Several participants noted that the budget percentage for instructional materials is too small (frequently about 1% of the total budget), forcing reliance on a long adoption cycle. One participant said that a state funding increase decreased local funding.

Respondents said reviewers are compensated poorly, if at all. Too little time is allotted to review: "State evaluators are expected to review as many as 1,000 items in a month," according to one respondent. A respondent from a non-adoption state reported that teachers perform the same task on their own time.

Although most of the survey participants agreed that experienced mathematics teachers should play a major role in selecting materials, these teachers may not be able to participate because of limited funding for release time and substitute teachers. A shortage of qualified mathematics teachers further limits active participation. The result, according to one respondent: "Often times, only the major textbook companies' publications are considered due to the lack of math specialists in each district."

Participants made these suggestions for improvement.

- Increase funding for mathematics materials.
- Earmark funds for texts and supplementary materials.
- Make sure state funding does not supplant local funding.
- Allow reviewers adequate time to evaluate materials, and pay for their expenses during selection.
- Pay for the release time and substitutes so experienced teachers can participate in the selection process.

Teacher Competence

Respondents in both adoption and non-adoption states suggested that teachers, for the most part, choose materials similar to those they have already used. Participants also thought that teachers are more likely to choose content-oriented, drill and practice materials than materials that encouraged inquiry, problem-solving and the use of calculators.

According to several respondents, this problem stems from inadequate or incomplete teacher training in the subject matter and the use of instructional materials. Again, shortages of qualified mathematics teachers contribute to the problem; in many areas mathematics teachers are not fully certified in the subject area. These teachers may not be able to use textbooks with a demanding content or innovative instructional approach. To meet the needs of less competent teachers, "the textbook needs to be at a level that is self-explanatory, not too complicated and does not require a deep understanding of the subject matter."

Further, even fully certified mathematics teachers may be compelled to "repeat their own [learning] experience." In other words, if teacher training at the postsecondary level relies heavily on memorization and drill, and uses materials that emphasize these techniques, then graduates are ill-prepared to choose for their students materials that require more sophisticated instructional techniques.

Whatever the reality, the perception of teacher incompetence affects textbook selection. As one respondent noted, "What is selected locally is the lowest common denominator, because the teachers with the poorer mathematics background don't have enough knowledge to make a good decision." Committee members may therefore feel they are justified in eliminating materials that challenge teachers.

Two respondents indicated that state adoption lists restrict teachers with high ability, particularly where funding for alternative materials is unavailable. However, several participants suggested that the best teachers rely less on texts.

Respondents offered a variety of suggestions to improve teacher competence to select materials.

- Ensure that members of selection committees have a thorough knowledge of subject matter. Require that prospective teachers be trained in the selection and use of materials.

- Make local education agencies aware that text purchases alone do not make a good mathematics program. Support teachers who develop their own approaches and materials.

- Treat teachers as professionals with authority to choose books. Use recommended, rather than required, materials lists. As professionals, teachers should have the authority to choose texts, and they are happier with materials they select themselves.

- Provide regional inservice workshops on reviewing and selecting materials.

- o Identify ability levels to which the materials are best suited.
- o Develop leadership programs that enable more proficient mathematics teachers to help the less proficient.
- o Provide incentives (such as continuing education credit) for teachers willing to develop and share expertise in selecting better mathematics materials and instructional approaches. All districts need someone who keeps abreast of new materials and trends.

Reviewer Appointment

Choosing a committee to select instructional materials is often a highly political process, whether the committee is appointed by state officials, or school principals. At both levels, survey respondents complained of cronyism and too-close relationships among longstanding committee members, education staff and publishers' representatives. The biggest drawback is that committee members may therefore not know enough about mathematics instruction or the curriculum to make appropriate selections.

"In a small district, teachers within a school may be able to work together on textbook selection," pointed out one respondent. "But in larger districts, the best they can hope for is representation on a committee that chooses for the whole district." But respondents indicated that teachers serving on selection committees are not necessarily the strongest mathematics teachers. One participant reported that, because vocational education and mathematics materials were selected on the same cycle, the selection committee had members from both disciplines with no additional weight given to the preferences of the mathematics teachers in the selection of mathematics texts.

Many respondents said that reviewers are chosen arbitrarily. Many states have no criteria for choosing reviewers. Elsewhere, criteria for choosing them are vague or inappropriately based on role (e.g., a teacher, an administrator and a parent) rather than on qualifications. Several respondents felt that the lay public, no matter how well-intentioned, is not generally qualified to review mathematics materials.

Participants suggested that the choice of reviewers be based on these criteria:

- o Mathematics background and experience
- o Familiarity with the curriculum goals
- o Understanding of the selection criteria and their application
- o Awareness of materials on the market and their most appropriate use

Reviewer Training

Many survey participants reported that reviewers are trained for state adoption committees, but several commented that this training is not very extensive. One respondent said that reviewers "receive two hours of training plus a copy of the rules and regulations that guide the state textbook adoption." Another noted that reviewers are told how to complete the evaluation form, but not how to evaluate a textbook.

The training of local selection committees is reportedly very limited. A few respondents described district training processes but most reported that there is no local training. Some participants complained that the state does not share information about effective training programs.

Most respondents felt that training selection committees would result in the adoption of higher quality materials. Such training might include:

- Discussion of the selection process, of curricular frameworks and goals, of applicable student assessment instruments, and of current research in mathematics instruction.

- Review of the criteria for selecting materials, and how to apply the criteria. Committee members might, for example, apply the criteria to sample materials. They also might evaluate examples of good and bad criteria.

Use of Outside Experts

Publishers' representatives are the "outside experts" most widely consulted, according to several participants, even though sales representatives cannot be expected to offer much information on their competitors' products. In some areas, state mathematics specialists and curriculum advisers are available to assist in the selection of materials. But several respondents indicated that these experts rarely participate in the local process. Most respondents in adoption states reported that outside experts are, however, consulted in the state process. A few respondents were skeptical about the use of outside experts, but others supported the practice. Although there was no consensus on the issue, several respondents suggested that a national consortium of experts could consider physical characteristics of materials, readability, currency and accuracy of materials and then disseminate this information to selection committees.

Selection Criteria and Application

A large number of participants indicated that market pressures from large adoption states render selection criteria irrelevant. As a result of this pressure, many find few major differences in materials. Still, some survey participants reported progress in the development of criteria which, if properly used, could lead to adoption of higher-quality materials. Many recommended the criteria developed by the National Council of Teachers of Mathematics.

But respondents found that criteria have had little impact on local materials selection. "Teachers don't usually have the time to really qualify instructional materials against

their adopting unit's stated curricular requirements. Tables of contents, indexes, scope and sequence charts and thumb tests are too often relied upon," said one respondent. Several complained that even the large adoption states do not follow their own criteria well: "In Texas, the texts do not fit the guidelines or match what they call for in content."

Participants warned against highly specific criteria for a variety of reasons. To respond to the highly specific, and different, criteria set by large adoption states, publishers include indigestible masses of information in textbooks. Criteria that are too specific are less effectively applied than flexible criteria; local selection committees, in particular, are not likely to use detailed criteria very effectively.

Survey respondents did not feel that readability formulas adversely affected mathematics materials. But several commented that learner verification data would be more useful if its accuracy and currency could be more easily checked. They also thought that teachers should be more involved in the learner verification process.

Respondents made these suggestions to improve selection criteria and their application:

- Make sure that criteria accurately reflect curricular goals.
- Develop criteria flexible enough to apply to a variety of materials and straightforward enough to be used effectively.
- Recognizing that publishers use the criteria as a basis for text revision, keep criteria up to date.
- Encourage local education agencies to use selection criteria.
- Training selection committees in the use of criteria, if possible with the assistance of the people who developed the criteria.
- Find out from selection committees how easy the criteria are to apply, and use the findings to revise the criteria.

Other Problems

Limited communication among adoption states was considered a problem by several participants. Even though states have not yet reached consensus on a core mathematics curriculum, most respondents felt that there are very few areas of major differences in state needs. Several respondents indicated that until inter-state differences are discussed and resolved, publishers will continue to respond to the dozens of different requirements and criteria of the largest markets.

Many participants decried the lack of communication within and among districts as well. Local education agencies and schools that have had a bad experience with a set of materials need ways to "spread the word." Publishers are likely to capitalize on good recommendations, but they are not motivated to circulate complaints.

Implementation

Staff Development

When participants were asked if teachers and administrators would have problems accepting new materials more than half of them answered yes. The participants who did not foresee problems almost unanimously added this qualification: if there is sufficient staff development in the use of new materials.

Lack of staff development encourages teachers to continue selecting outdated materials, and limited exposure to new approaches stifles even the best teacher's inclination to change. "Good teachers are very busy," wrote one respondent. "Dropping a new approach on an unprepared teacher is like trying to insert a three-pronged electrical plug into a two-holed outlet. The teacher will either 'trash' the new approach or bend it to familiar methods . . . Elementary school modern methods materials were an excellent example." Another respondent wrote that "implementation and infusion of new material is a slow process that requires extensive support for teachers." A third person described staff development in mathematics as "inadequate — inappropriate — optional. . . . Materials are purchased and then not implemented in a committed manner — they sit around because of inadequate training on use and follow-up."

Respondents cited problem-solving and the use of calculators in instruction as specific areas in which teachers need training; teachers who are most comfortable with whole number calculation and drill-and-practice techniques were reportedly most resistant to new approaches.

Lack of mathematics leadership was seen as a problem: "There is money available to provide workshops and courses in new ideas. What is lacking is clear leadership in the middle and lower schools in formulating a direction and a coherent program." Another respondent saw "little hope for the upper-ability students in districts with little curricular leadership at the top. . . . A concentrated effort by the state to provide mathematics leadership conferences for teachers would do much toward improving the textbook and material selection process."

The following suggestions were offered to improve staff development:

- Ask publishers to provide consultants qualified to help train teachers.
- Evaluate the training publishers provide.
- Take time to explain why a change to new materials is important.
- Give teachers enough time to become familiar with new materials.
- Provide teachers with information on new approaches and recent research on a regular basis. Dropping five years' worth of information on teachers just before they are asked to use new materials does not convince them of the worth of the changes.
- Make sure that administrators understand the value of new materials to encourage committed implementation.

- Help the best mathematics teachers become leaders.

Differential Effects on Students

Nearly 25% of survey participants felt that selection procedure problems adversely affect all students, regardless of ability. According to one participant, "limited knowledge of textbooks by adopting districts could have a detrimental effect on any students for whom adopted materials is inappropriate." Several reported that fewer good materials are available for some groups, particularly for students with limited English ability.

Most of the remaining 75% of respondents found that the procedure affects high-achieving students and low-achieving students differently. High-achieving students are adversely affected when texts are selected by individuals with a limited mathematics background and when only a single text is adopted. Though most participants indicated that able students would do fairly well regardless of the materials, they considered these students "cheated due to lack of enrichment or the lack of attempts to increase their interest in mathematics." Low achievers are adversely affected by the selection of texts geared toward average or college-bound students. In the words of one respondent: "We force the kids to be remedial, and society, because of this, guarantees a mathematical underclass." Several participants added that because low achievers have the poorest teachers as well as inappropriate materials, they are doubly shortchanged.

III. CONTENT

Problems with Current Materials

Problem-Solving

Although a few respondents applauded recent efforts by publishers to include problem solving in mathematics materials, most flatly stated that textbook companies pay "lip service only" to problem-solving and that it is "largely a buzzword, especially at the secondary level." One survey participant warned against revising materials "too readily to 'fads' in education. For example, it can be argued that secondary math content in textbooks was adversely altered when back to basics was popular. Perhaps publishers overreacted to that trend as they did to 'modern' mathematics when they put properties and sets in all material in all grades for all students."

Many respondents sympathized with the precarious position of publishers, noting the wide gaps between what state and local officials say they want and what they actually select. Selection criteria and text specifications frequently require the inclusion of problem-solving, yet teachers continue to select more traditional materials that emphasize drill and practice. One respondent aptly noted that "emphasis on pencil-and-paper skills precludes the utilization of new instructional strategies for teaching problem-solving." (Also see, Effect of Graduation Requirements and Tests on Content, below.)

Still other participants suggested that publishers and writers may not understand problem-solving.

> Texts reflect a misunderstanding about what constitutes a "problem." Those that devote sections to "coin problems" and "mixture problems" and the rest are, in fact, providing a method to approach a particular type of exercise, and a not particularly useful exercise at that. There seems to be a minimum of real problems, questions that require the student to think in a way, or to apply mathematical knowledge in a way, that the student has not done before.

Effect of Graduation Requirements and Tests on Content

Most participants felt that tests and the content of mathematics materials are too congruent. For example, one respondent wrote that "tests lag; they reward mechanical skills. Out-of-date tests have a stagnating influence on texts." Another noted that "there is little in the way of estimation, calculator/computer use, open-ended problem-solving and related activities in the tests, yet these are important goals for the mathematics curriculum."

Several respondents indicated that standardized testing restricts the curriculum if it is relied on too heavily. One participant claimed that "the bond between some school districts and a standardized test limits consideration of books that are not topically congruent." Another suggested that low-achieving students "receive too much

mathematics too soon, due to everyone's wish that they pass standardized tests."

Participants also commented on the relationships between curriculum requirements, standardized testing and content of instructional materials:

> Many of the state and district responses to the movement for tougher requirements have had a harmful effect in freezing certain things in place and in focusing teachers' (and textbook writers') attention even more on what the tests are testing For example, requirements that all college-bound students take two years of algebra and one year of geometry have thwarted attempts to integrate algebra, geometry, statistics and computing into a three- or four-year sequence. Teachers are abandoning tentative attempts to introduce more problem-solving activities into the mathematics curriculum because such activities are not covered on standardized achievement tests or state minimum standards tests.

"Ideally, new requirements should spur branching out in new directions," pointed out another participant. "But, instead, the curriculum may just get watered down."

Several respondents were concerned that a "wide variety of appropriate high quality materials may not be available for more courses." Others wondered who will teach the additional mathematics courses students are required to take. A few participants commented that quality in the curriculum was more important than the quantity of courses required: "We should teach well what we already have. One more semester won't do if we don't have excellence in the program."

Controversial Topics

According to nearly all the survey participants, publishers are very conservative. Although mathematics is a "culture-free" discipline, there are still areas into which publishers are unlikely to venture. One respondent noted that "anything offensive to anyone is removed." For example, "policy decisions based on pressure from special-interest groups is in part responsible for much of mathematics being primarily the arithmetic of whole and positive rational numbers."

Cited most frequently as a topic of controversy was the use of calculators. Several participants noted that state frameworks now emphasize the use of calculators, but none reported the availability of related materials. Measurement, estimation, manipulation and mental computation are among the other topics not now represented in textbooks.

Match Between Curriculum and Content

Participants worried that setting minimum competencies has seriously affected content, for minimums have come to be seen as maximums. One state's curriculum guidelines "stress only the basic operations and concepts in mathematics, leaving problem-solving only as a by-product," for example.

Otherwise, respondents from large adoption states and a few large districts felt that materials generally do match curricular goals, though a few of them were concerned that the curricular requirements are too specific. For example, one state "has an integrated curriculum with specific materials to be covered at each level, and textbook publishers are lining up to fit their materials to [the state curriculum]. So . . . classrooms are lock-step taught — there is the same exam throughout the state — the same subject is tested in the same way throughout the state. Currently there is a (matching) textbook series in draft for grades 9-12; and there will be for grades 7-8 soon." Respondents.in non-adoption and smaller states, on the other hand, did not believe that content of mathematics materials matches curricular goals. A few felt that no match is possible because state guidelines are too vague and local guidelines are too specific.

Breadth vs. Depth

All of the participants who considered coverage a problem indicated that depth has been sacrificed to breadth. Most felt that publishing companies have little choice:

> The major problem is in the 20-odd state adoption states, where disparate selection procedures and standards force each publisher to produce a single textbook program that, hopefully, will meet all their needs. . . . This can produce instructional materials that are lengthier than necessary, but achieve an economy of scale: schools' low funding level for instructional materials eliminates publishers' ability to produce a variety of programs in each discipline to meet various schools' needs.

Respondents thought that excessive breadth creates problems for teachers. Teachers rarely have enough time to decide what to leave out, and some do not have enough background in mathematics. Deciding what to teach was considered a particular problem for teachers who proceed "page by page."

One respondent blamed excessive breadth for a lack of continuity in textbooks.

Currency and Accuracy

Some respondents considered currency of materials a problem. Long adoption cycles and insufficient funding were the culprits, according to some: "A dollar commitment for instructional materials that does not provide for more than textbook/teacher edition packages excludes currency, discovery, and expansion of methods and materials." Another wrote that it "is not too unusual for some of the poorer districts to have very old books. There is no requirement or monitoring to keep books current."

Several participants noted that copyright dates are not a good gauge of currency.

> Many textbooks get the copyright changed, when in reality there is very little change in the content. (A 10% change in content is enough to allow the copyright to be changed.) However, the state contributes to this problem because of the six-year adoption cycle; new editions and old editions of the

> same book must be fairly comparable to be used in the same classroom. So restrictions of the state hinder change; however, it also means that the original text which is adopted should be real good.

According to another participant, "what exists, especially at the secondary level, doesn't accurately reflect the results of research in the last 5 to 10 years. Extant texts are written with the traditional instructional implications even when they attempt to suggest they incorporate fashionable "buzzword" topics."

A few participants also considered accuracy of materials to be a problem. One offered the following example of questionable math practices: "In solving x-3=2, many books advocate expressing the equation as the union of x-3=2 and x-3=-2 instead of (x-3)=2 and -(x-3)=2, which translates immediately into work with inequalities and which is mathematically sound." Another wrote that materials "need more honest applications, not just dreamed-up experiences that don't apply."

Differential Effects on Students

Low-achieving students and students not bound for college were the groups considered hardest hit by content problems. In high school, for example, "schools seem to either focus on the pre-college mathematics/science major or at least on those on the college prep track." Not enough is being done for students on other tracks, particularly where money for supplementary materials is tight. "College requirements determine what mathematics will be taught in traditional secondary schools," pointed out one respondent. Content tailored to the needs of limited English students and those not going to college "tends to be computation-oriented," wrote another.

If the response to the perception that materials have been "dumbed down" will be to make texts more difficult across the board, low-achieving students will face particular problems. Several respondents expressed the fear that "increasing difficulty of texts may result in more harm because high achievers are known to cope with most (many) situations, but the low achievers can't cope, and they will drop out in greater numbers."

Other respondents complained that because high-achieving students are considered more able to cope, their particular needs are largely ignored. The majority of participants indicated that content is geared toward students of moderate ability.

Participants made these suggestions for improving the content of mathematics materials.

- Train teachers to select and develop their own materials. (This suggestion reflects a philosophy that many respondents shared: instructional materials are merely tools, and the best teachers play an active role in deciding which tools to use and how.)
- Improve the training of teachers in mathematics, because teachers confident of their mathematics abilities will demand and select better texts.
- Incorporate information on trends and how they affect content into local staff development.
- Publishers need to make a greater variety of texts available, define ability levels of

texts, and integrate new trends and research findings into texts.

- States, publishers and curriculum experts should work together to match curricular goals and text content.
- A national core curriculum should be developed for mathematics.
- Several states should study the factors hindering high-quality content in mathematics materials and disseminate the results.

IV. INSTRUCTIONAL DESIGN

Problems with Current Materials

How Teachers Use Texts

Respondents felt that materials are not used to their best advantage in the classroom. Many of them noted that teachers tend to provide instruction "page by page." Some indicated that materials are designed to encourage this, locking teachers into a rigid framework. "Instructional design has been oversold as something that can occur in the absence of the teacher who will do that instruction," commented one respondent.

Although a few participants noted that teachers prefer materials that they can "march through, section by section," others felt that limited time and training forces teachers to use this approach: "Teachers have so many other non-teaching chores that they may not be able to really use texts effectively." One respondent added that the lack of supplementary materials encourages dependence upon textbooks. Another found that publishers "are getting better at making their texts teacher-proof. Whether this is desirable is questionable."

Quality of Writing

According to one participant, writing is better now than in the past, but explanations in mathematics materials have become fewer and shorter. Now texts contain lots of white space and lots of practice exercises. One respondent saw a "desperate need for more clarity in the writing section" of textbooks. Another considered the writing level of texts to be too low and geared to the low-average student, adding that materials do not "use good conceptual models, do not have enough action by the child, don't get children to truly think." Commented another respondent, mathematics "is inherently difficult to read. Students need to be taught to read mathematics (to read closely and consider the implications of what they read). Clearly, publishers have addressed this."

Use of Supplementary Materials

Computer software is most frequently investigated as supplementary material, according to survey participants, though most were not enthusiastic about the quality of software available or its integration to mathematics. Software supplements were described as "drill-and-practice components with a management system and blackline masters for duplicated drill-and-practice worksheets." Another problem with software: "there is so much out there that it is hard to determine its effectiveness."

One respondent felt that all supplementary materials "could be more imaginatively done, especially at the secondary level." Several respondents felt that supplements are good but not affordable: "The use of supplementary materials and teacher manuals make a difference in those districts having sufficient funds or teachers motivated to consider them in the selection process."

Use of Teacher Manuals and Instructional Guides

The most common complaint about teacher manuals was that they encourage teachers to depend on them too heavily: "These manuals and guides should be aids to teachers, but in many cases textbooks can't be used without them." Thus, guides are "presently used as answer books could be." One respondent found it pointless to take material out of textbooks and put it into a teacher's manual so that the students cannot see it.

Several participants indicated that instructional guides should focus less on content and more on interesting ways to present content. Teacher manuals might include some background information and results of research on instructional techniques. One respondent said that teacher manuals "need to include how to teach with manipulatives and child explorations."

Organization of Materials

Some respondents indicated that textbooks are frequently organized around the schedule (a lesson a day) rather than content, causing instruction to be "choppy or low intensity. Concepts tend to be treated equally, regardless of importance."

Others noted that mathematics books "use a pattern, e.g., subtraction exercises are all in one part of the book. So, the child can outguess the book on what will be required in particular problems because of the location in the textbook." One participant suggested that text organization tends "to subvert understanding by encouraging students to put one finger on the example and one on the problem, and copy."

Another organizational problem is the tendency of publishers to "update" materials simply by adding word problems for problem-solving at the end of each chapter. While this may impress selection committees looking for the inclusion of current techniques, it may not make for a cohesive lesson.

Use of Graphs and Pictures

Several respondents considered graphs and pictures desirable in mathematics instruction, and one found them particularly useful for teaching probability and statistics. A few participants were concerned that the location of pictures and graphs is not always appropriate to the content. One participant complained about "how quickly the rule is given before adequate concept development using a pictorial level — guided practice with pictures."

The costs and benefits of extensive illustrations were debated. One respondent commented, for example, that:

> the use of four-color printing processes is universal among elementary mathematics textbooks. Yet, there is no body of evidence that the use of four-color processes leads to materials associated with improved learning. There is evidence that it improves sales; in fact, it is regarded as necessary for sales. The extra production costs associated with four-color processes may be a luxury.

Another said "too much money goes into visual impact and overwhelms content."

Differential Effects

Instructional design problems adversely affect all students, according to five survey participants. "Textbooks really cannot show enough variance to serve all of the special groups. . . . The result is a compromise — minimally serving what is common to all student populations." Several respondents again indicated that low-achieving students suffer more than other groups. The students who hope to enter the work force after they graduate will be at the most immediate disadvantage when their mathematics background is poorly developed.

Another group of respondents found that high-achievers and students entering college are affected by current instructional design. "Over the last 10 years or so, there has appeared a proliferation of math texts designed for the lower echelon of students that contain a minimum of words, a lot of rote exercises that utilize only small integral constants with nice integral answers, a lot of the same questions asked in the same ways, no attempt at discovery learning, a minimum of built-in review. . . ."

Respondents offered a variety of suggestions to improve the instructional design of mathematics materials.

- Educate teachers about the appropriate use of instructional materials — during postsecondary training, before certification, or through inservice offerings.
- Then provide materials that support what teachers have learned.
- Encourage teachers to use their own initiative in developing and using materials. Describe materials as tools, explain how to use them, and expect teachers to use them appropriately.
- Use only materials that meet instructional objectives.
- Increase communication among publishers, state officials, districts and schools so that information on the pluses and minuses of instructional materials reaches the people who can take constructive action. If materials are ineffective, make sure there are ways to offer publishers suggestions for improvement and to inform teachers of problems.
- Base instructional design on research.
- Involve more people in the development of instructional materials. Ask developmental learning experts, professors of mathematics education, cognitive mathematics researchers, and teachers to preview, review and pilot new series.
- Support research on spiraling, pacing and other new strategies for instructional design. Encourage writers to work with researchers on approaches that could raise student achievement.
- Use teacher manuals to describe how content can be presented. Emphasize, for

example, which topics need only brief treatment and which need thorough coverage.

- Design more open-ended materials that allow teachers to initiate activities and follow up in their own ways.

- Spend less on the physical appearance of materials, concentrating instead on quality and flexibility of instructional approach. For example, a high quality loose-leaf series could include supplementary materials (such as ditto masters and several versions of the same test) and be flexible enough for use by students of varying ability, without substantially altering core content.

- Relate concepts more closely to one another so that students can make conceptual connections.

- Vary the presentation of materials so that a repetitive structure does not allow students to guess what comes next rather than thinking about concepts.

V. NEW TECHNOLOGIES

Survey participants were asked whether and how new technologies (like those that allow mass-produced books to be tailored to specific purchases, for example) will affect mathematics materials. Some of the half-dozen respondents who contended that new technologies are not yet having much effect doubted that they ever will: "the impact in the near future will be minimal, the costs are underestimated," "will have a superficial impact only"; "not much impact now, will diminish even further," "you can't impose technology on an old structure. There won't be any major impact of technology unless there is a change in the structure of the delivery system." One participant indicated that "new technology will only be a factor in affluent schools or in areas with a high-tech job market."

More than twice as many respondents believe that technology will eventually have an impact, though that impact lies at least 10 years in the future. Some felt the impact will be greater if technology is used as a tool, not treated as a subject, and if software is well-integrated with other materials.

Participants suggested that new technology might have an impact by:

- Providing computer-assisted simulations, models and drill
- Providing demonstrations, diagnosis and remedial work
- Helping students develop problem-solving skills
- Supporting traditional delivery systems, particularly for special populations
- Making a wider variety of materials available
- Allowing application of mathematics in real settings
- Making teaching less labor-intensive.

They also described the conditions that limit the use of technology. A lack of money for hardware, software and consultants was cited most frequently, followed closely by lack of training for teachers. Said one respondent, "Computers will become like instructional TV if we do not provide adequate training." The poor quality of much software was also considered a limiting condition; as one person commented, too often software fails to stimulate the imagination. According to another respondent, software to date "does nothing more than an expensive workbook. . . . We need the child to truly interact with the computer, and to do that means to have the child in charge." Four participants noted that time constraints limit the use of technology; in particular, there is too much software to wade through to make the effort worthwhile. Other limiting factors included:

- Attitudes of teachers, some of whom will not use a calculator in class, much less a computer.
- Lack of good criteria for evaluating software.

- Current curricular requirements and current tests do not allow for technology applications.
- Lack of communication between researchers, software producers and publishers.

VI. CHANGES IN PUBLISHING PRACTICE

Development of Materials

Almost all respondents wished that education leaders in mathematics were more frequently consulted during the development of mathematics materials. Specifically, they wished that publishers would accept advice from professional organizations (such as the National Council of Teachers of Mathematics), education psychology experts and mathematics education professors.

Most respondents felt that publishers should spend more time to develop high-quality materials, perhaps up to five years including pilot testing and learner verification. Although survey participants considered it wise to have one person in charge of the development of a series, they did not think editors should handle this responsibility, but rather someone more familiar with mathematics education delivery. They also thought that mathematics educators should be consulted in the development of instructional guides and teacher manuals.

Many respondents recognized that the market in large adoption states places tremendous pressure upon publishers to cover everything that anybody wants but they urged publishers to "take a risk" and develop materials for smaller markets. Publishers might, for example, design materials for talented and gifted 6th grade students, or for accelerated students in elementary school. Mathematics materials published in smaller segments might be useful if thorough instruction in their use were provided. So might open-ended materials, with supplements targeted at student ability groups.

Several participants suggested that textbook companies pay close attention to changes in criteria for selecting materials that are accompanying education reforms. Many respondents suggested that curricular requirements are becoming more similar across the states, and several called for a national core curriculum in mathematics. Astute publishers could offer high-quality, cost-effective materials tailored to such a core curriculum. Several respondents suggested that texts identify grade and ability levels. Publishers might even sponsor conferences on curriculum development and fund related research.

A few respondents felt that too many supplementary materials are on the market. But others favored the development of more supplements, perhaps keyed to main textbooks. If the main text were of the highest quality, and covered a core curriculum, revisions would be largely unnecessary. Then supplements might be used more extensively to meet changing needs.

Eliminating peripheral information from basic texts would alleviate problems of choppy segments. One respondent noted that there is a lot of "dead wood" in many secondary mathematics textbooks, like logarithms, that should be deleted. Supplements could also be used to match differing state requirements; supplements keyed to the main text could be used to alter sequencing of content.

To capture new markets, publishers follow new trends too quickly. Current trends include an emphasis on problem-solving, for example, and an interest in software to accompany printed materials. But while participants applauded publishers' zeal to

respond to these trends, few were pleased with the integration of problem-solving in materials, and even fewer were pleased with software supplements. The addition of "buzzwords" and the haphazard inclusion of concepts currently in vogue does nothing to lessen educators' suspicions that publishers revise materials merely for the sake of a recent copyright date.

"Recent copyright date" almost always appears on lists of selection criteria and publishers must therefore revise texts often. Yet, revised texts are often used at the same time as earlier editions, a difficult task if the new edition is vastly revised. Participants urged publishers to ask states to relax the requirement for a recent copyright date, on the grounds that the requirement leads to continuous and confusing revisions. Instead, respondents suggested publishers should examine their materials closely and consult with instructional design and mathematics education experts. They should then publish the core of what appears in most mathematics curricula and spend revision money to develop supplementary materials that keep the text current and flexible.

Sales and Use of Materials

Publishers can legitimately argue that funding for instructional materials, typically less than 1% of a district's budget, is too low. Indeed, nearly all survey participants recommended increased funding. Even if funds increased, however, most respondents would prefer to see lower costs for basic texts and greater emphasis on training the teachers who will use the materials.

To lower the cost of basic texts, respondents suggested that publishers stop giving away materials to influence adoptions. As one respondent stated, "Nothing is free." The practice keeps prices artificially high, and it can lead to the adoption of low-quality or inappropriate materials. They suggested that publishers use new technology to keep materials up to date, using a loose-leaf format, for example, or less expensive binding processes. Participants also considered the huge amounts of money publishers spend on advertising materials to be of dubious value: disseminating information on a product is important, but massive advertising does little to improve the selection and use of materials. Publishers might work more closely with educators to determine how to keep costs at reasonable levels.

Respondents indicated that the inservice programs publishers often provide vary dramatically in quality. They urged publishers to continue providing inservice programs, and suggested that program quality would improve if publishers, in cooperation with education officials and teacher training institutions, used mathematics education experts or people with experience in adult education as trainers. In particular, respondents did not feel that sales representatives were qualified to present inservice programs.

Publishers should pay attention to how teachers use materials. Staff development programs conducted jointly by textbook companies and education officials might identify whether teachers are using materials effectively and, if not, whether the problem lies with the teacher, the materials, or both. Materials need to be teachable in and of themselves; but workshops that promote understanding of the design, concept and organization of the materials, can be useful for diagnosing and solving problems.

Participants noted that the sales practices of some publishers strongly support the status

quo. For example, learner verification data is rarely used to revise materials and rarely represented accurately during the sales presentation. Pilot data and learner verification information should be thoroughly analyzed and made widely available. Though publishers need not take full responsibility for such an expensive process, they should cooperate with the professional groups and education officials who seek to use this information more effectively.

Publishers also need to integrate computer software with other instructional materials. To develop more coherent software, publishers should consult with mathematics experts and specialists in instructional design.

In sum, survey respondents suggested that publishers encourage the selection and use of high-quality materials in the following ways:

- Consult with education experts during the development and testing of instructional materials.
- Take time to develop materials carefully.
- Develop innovative, high-quality materials to meet the needs of varying student ability levels.
- Work with education officials to define a mathematics core curriculum and develop materials to serve such a curriculum.
- Use supplements to keep materials current rather than constantly revising basic texts.
- Analyze new research and current trends carefully to determine what type of revision, if any, are appropriate.
- Make every effort to keep costs down.
- Encourage increased funding for training teachers to use materials.
- Sponsor research in curriculum development and identify effective staff development programs.
- Make learner verification and pilot data more widely available. Make those data a basis for text revision.
- Consult with experts who can integrate software with printed instructional materials.

VII. CHANGES IN STATE PRACTICE

Development of Selection Criteria

Criteria lists and text evaluation forms are becoming more widely available. But the criteria may not always be used, particularly if they are too rigid or do not apply to a variety of materials. Development of criteria that can be easily applied is a high priority. The criteria must reflect curricular goals accurately, yet not be over-specific. The effect of testing instruments on curricula should be considered, but education officials must recognize that most testing programs reflect minimum standards, not curricular goals. Cost should not be the primary criterion for the selection of instructional materials.

Teachers with experience in the use of materials should be more widely consulted during the development of selection criteria. Specifically, teachers should be asked to identify practices and approaches that increase student competence in mathematics.

Selection criteria should specify not only core content but also the instructional strategies teachers find most effective. The idea that one rule fits all situations must be abandoned; criteria for selecting vocational education materials will probably not lead to selection of high quality mathematics materials, for example.

States must reduce the pressure on publishers to revise mathematics materials constantly. Criteria should allow reviewers to gauge currency and accuracy, but the copyright date is not necessarily such a gauge. Since physical standards for durability are almost uniformly met by publishing companies, delineating these standards in selection criteria may not be practical.

Standards for computer-assisted materials and software must be developed. Software should, for example, augment the curriculum; software and textual materials should be integrated.

The Selection Process

Selection processes are rarely funded adequately, according to survey participants. More money is needed to train reviewers to use selection criteria and to practice applying the criteria to materials. More time should be allowed for the selection process, which means that the highest cost will be the cost of release time and substitute teachers.

In addition, funds for materials must be adequate so that selection is not based solely on cost. State funds should be earmarked for instructional materials; states should discourage local officials from using increased state funds for materials to supplant local funds.

State and local officials need to eliminate or at least limit political aspects of the selection process. Selection committee members should be competent to make decisions regarding mathematics instruction. Selection processes at the local level should give more weight to the opinion of experts inside and outside the system.

Local Implementation

State officials must work with local education agencies and publishers to help teachers learn how to use mathematics materials. Teachers need time to become familiar with new materials; and they need to be encouraged to use new materials effectively. Some teachers will need some background mathematics instruction before they can adequately use higher-quality materials. All teachers need, at minimum, an explanation of why the new materials were selected and a description of instructional design.

States, local education agencies, institutes of higher education, publishers, and professional groups all sponsor inservice or continuing education programs, but cooperation is sorely needed. The people who select materials should also be involved in the inservice program, for example, and publishers might provide consultants who developed the materials. (Indeed, selection committees and publishers might thereby become more accountable for their actions.)

Finally, states should disseminate information on mathematics materials and their most appropriate use. Here again, cooperation with publishers could be helpful. If a publisher, for example, designed a text for college-bound mathematics majors, the state could supply this information to teachers.

Relationships Between Educators and Publishers

State and local education officials must communicate their needs to publishers accurately and frequently. This requires that education officials first reach consensus on their needs and set priorities. Publishers and educators then need to maintain communication on evolving issues.

Groundrules regarding promotion and sales policies must be developed and followed. Just as education officials must learn to select materials that fit their curricula, publishers must learn to abide by rules of fair play. Lobbying selection committee members privately and supplying "freebies" do not lead to higher-quality adoptions. Some states now require publishers to publicly list free materials so that the materials can be available to all districts.

States and publishers should work together to encourage research on instructional materials and then to incorporate findings into materials during development, and into classrooms during staff development. Both should consult frequently with experts and with each other. States and publishers can also work together to support the independent review of materials at a national or regional level and the dissemination of this independent information to all state and local reviewers.

APPENDIX A

QUESTIONNAIRE

SURVEY OF PRIORITY ISSUES IN MATHEMATICS INSTRUCTIONAL MATERIALS

A. Textbook Selection Procedures

1. Are there any factors regarding the selection process in your state or local districts which hinder the adoption of higher-quality instructional materials in mathematics?

Consider the following:

a. state and local policies or state/district guidelines or statutes

b. available resources for purchasing materials and funding the selection process

c. selection and training of reviewers

d. use of outside experts as additional reviewers

e. selection criteria and their application (e.g. curriculum requirements, sex stereotyping, social content, learner verification, physical characteristics of textbooks, etc.)

f. competence of teachers to use new approaches

g. other problems:

2. How can these problems be overcome?

3. Do any of the specific issues/problems you mentioned above have differential effects on:

low achieving or high achieving students?
college-bound students with an intended major in science or mathematics?
college-bound students with an intended liberal arts major?
students planning to enter the work force after high school?
students with limited language competence?

B. Subject Matter Content

1. Are there any factors regarding the content of instructional materials in mathematics which hinder the adoption of higher quality materials?

Consider the following:

a. coverage of depth vs. breadth of topics

b. inclusion of controversial topics/role of special interest groups

c. currency and accuracy of materials

d. match between state/district curricula goals and textbook content

e. effect of test congruence on what topics are included in textbooks

f. effect of increased graduation requirements on content of instructional materials

g. direct instruction and practice vs. discovery or open-ended approaches

h. attention given to problem solving

i. other problems:

2. How can these problems be overcome?

3. Do any of the specific issues/problems you mentioned above have differential effects on:

   low achieving or high achieving students?
   college-bound students with an intended major in science or mathematics?
   college-bound students with an intended liberal arts major?
   students planning to enter the work force after high school?
   students with limited language competence?

4. In your view, if these changes were made, will there be a problem in teachers'/administrators' readiness to accept these new materials?

C. Instructional Design and Integrity of Instruction

1. Are there any factors related to the instructional design of mathematics instructional materials which hinder the adoption of high quality materials?

   Consider the following:

   a. use of pictures and graphs

   b. organization of materials (e.g. use of headings, titles, textual clues, summaries, questions)

   c. quality of writing

d. use of supplementary materials (e.g. student workbooks, computer software, laboratory manuals, tests)

e. use of teacher manuals and instructional guides

f. how textbooks are currently used by teachers

g. other problems:

2. How can these problems be overcome?

3. Do any of the specific issues/problems you mentioned above have differential effects on:

low achieving or high achieving students?
college-bound students with an intended major in science or mathematics?
college-bound students with an intended liberal arts major?
students planning to enter the work force after high school?
students with limited language competence?

D. Impact of New Technology on Instructional Materials

1. Practically speaking, will the new technologies (e.g. that allow mass produced books to be tailored to specific purchases or computer software that can be interfaced with existing instructional materials) have much impact on instructional materials in mathematics? If yes, how soon and in what ways? If no, why not?

2. What are the conditions that will limit the actual use of technology?

E. Implementation of Materials at the District or School Level

1. What are the major problems schools and districts face when trying to implement new, higher quality instructional materials?

Consider the following:

a. staff development in mathematics or the use of materials

b. relationship of instructional materials to other educational reforms

c. resources available for instructional materials

d. other:

F. Role of Publishers

1. What three changes in publishers' practices would lead to the development of

higher quality instructional materials?

2. What should the role of publishers be in supporting installation and continuing use of instructional materials?

G. Role of States

1. What three changes in state practices would lead to the use of higher quality instructional materials?

APPENDIX B

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